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INCREASING THE EFFECTIVENESS OF UTILIZATION OF MATERIAL FOR SPECTRAL ANALYSIS USING LASERS

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INCREASING THE EFFECTIVENESS OF UTILIZATION OF MATERIAL FOR SPECTRAL ANALYSIS USING LASERS

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ABSTRACT. In order to increase the effectiveness of the application of material eroded or evaporated by laser beam for spectral analysis, the authors placed a carbon tube over the aiming point on the specimen, then focused the laser beam through the tube. The material ejected from the specimen was deposited on the inside of the tube, then burned by ac current in order to produce the spectrograph.

The application of lasers for excitation of spectra permits spectral analysis of various materials, including non-conducting materials, to be performed with no preprocessing of the specimen material. /500*

However, the intensity of the spectra of the plasma produced by the action of the laser beam on the material with an energy of several Joules is not great, although the quantity of material ejected from the specimen would be sufficient if totally evaporated for the recording of intensive spectra under ordinary conditions of spectral analysis. This results from the fact that the quantity of material evaporated resulting in the line spectra, is only a small portion of the material ejected from the specimen by the laser beam impact, the rest being ejected in the form of rather coarse melted particles.

If an electric discharge acts on the material ejected by the laser, the intensity of the spectrum can be increased by more than an order of magnitude [1]. Here, the role of the laser is reduced to coating the electrodes with the material analysed, which is then burned in the electrical discharge, so that the effectiveness in the application of the material is increased [1, 2].

However, in this case as well, a very small portion of the material ejected by the laser action is used for analysis.

For more complete collection of the matter ejected, we used a carbon tube 5 mm in height with an outside diameter of 5 mm and an inside diameter of 4 mm, fixed to the surface of the specimen being studied. The collection of the specimen for analysis in the carbon tube was performed using a GSI-1 device with an energy of generation by the neodimium rod of about 10 J (Fig. 1). The laser beam, focused through the axis of the tube onto the surface of the specimen, caused the material to coat the walls of the tube, primarily at the base[1]. Then the tube and material were burned in an ac arc with a current of 4a. The spectra were photographed using an ISP-30 spectrograph with a slit

*Numbers in the margin indicate pagination in the foreign text

[1]This feature of the ejection of material by laser was discovered in preliminary experiments with brass specimens placed in glass tubes.

width of 0.03 mm on type II spectrographic film with a sensitivity of 22 State Standard Units. The time of exposure was 1 minute. The intensity of the spectra produced by this method of material collection was more than an order of magnitude (about 20 times) higher than in the case of applying a laser in combination with an arc discharge (Table 1), and 2-3 orders higher than the intensity of spectra produced by the radiation of the flame formed by disruption of the specimen by laser radiation. /501

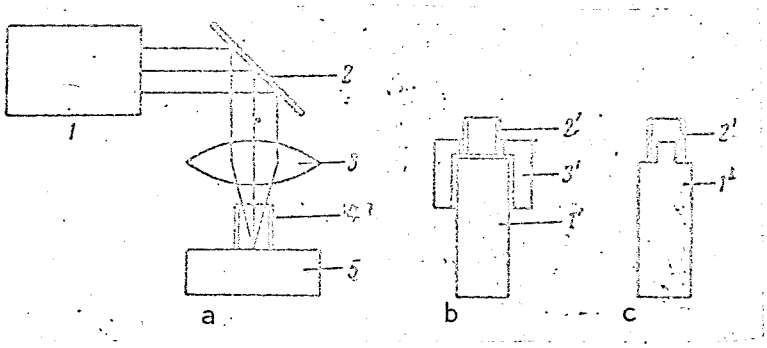

Figure 1. Diagram of Device for Collection of Material by Laser for Spectral Analysis: a, collection of material on carbon cylinder (1, laser; 2, mirror; 3, lens; 4, carbon tube; 5, specimen being analysed); b and c, methods of fastening carbon tube to electrodes for burning of material collected (1', carbon electrode; 2', carbon tube; 3', carbon collar)

An evaluation of the reproducibility of intensities of spectral lines in comparing the two methods of collection of matter for analysis (on a pair of electrodes and in the carbon tube) showed that when the material is collected in the carbon tube the error is somewhat higher (see Table 2); this results apparently from the transfer of relatively large particles of material to the walls of the tube. When burned in the arc, these particles may fall from the wall before being fully burned. /502

TABLE 1. COMPARISON OF INTENSITY AND ERROR OF REPRODUCTION WITH TWO METHODS OF SAMPLING OF MATERIAL BY LASER RADIATION

Line, Å;	Intensity, units;	Arith. mn. error in repro. intensity, %,	Intensity, units;	Arith. mn. error in repro. intensity, %	Increase in spectral Intensity;
	Material transferred to pair of electrodes		Material transferred to carbon tube		
Cu I 2824	10	48	267	49	в 27 times
Cu I 2961	16	41	255	52	в 16 times
Zn I 3076	12	29	278	35	в 23 times
Mean		39		45	в 22 times.

TABLE 2. ARITHMETIC MEAN ERROR IN REPRODUCIBILITY OF RELATIVE INTENSITIES, %

Analytic Pair of Lines, Å;	Transferr of matter to pair of electrodes	Transfer of matter to carbon tube
Zn I 3076— Cu I 2824	13	23
Zn I 3076— Cu I 2961	14	30
Mean	16	26

The investigations performed with specimens of binary copper-zinc alloys and silicon brasses showed that the method suggested for collection of matter by laser allows the influence of third elements to be eliminated in spectral analysis of these alloys, within the limits of error of the experiments; the standard points fall on a single calibration graph.

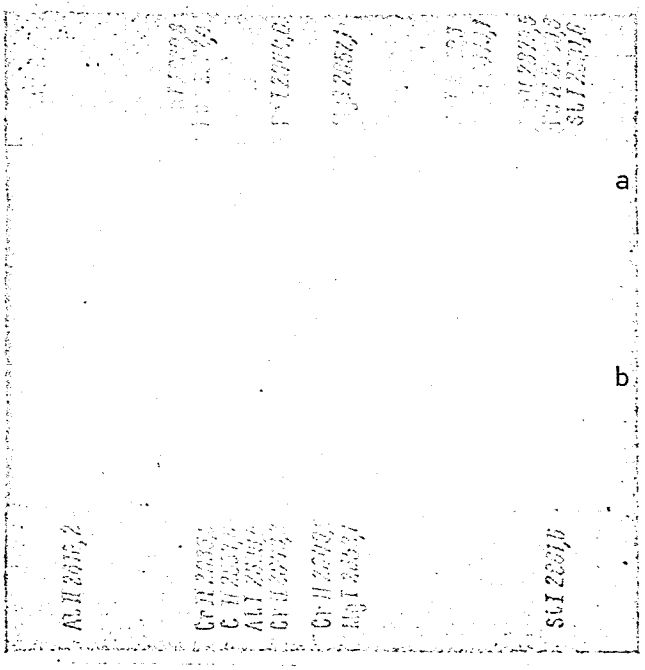

Figure 2. Spectrograms Produced by Burning Matter Collected by Laser: a, ferrite; b, ruby

This method of collection of matter for analysis can be used successfully for spectral analysis of solid, nonconducting materials such as ruby, ferrites, etc. (Fig. 2). In contrast to the collection of matter on a film [3], the method which we used allows both low (~0.1 J) and high energy (~10 J) lasers to be used.

Coating of the inside of a carbon tube with the material by means of laser radiation, apparently, can be used for collection of matter for local spectral analysis.

REFERENCES

1. Panteleyev, V. V. and A. A. Yankovskiy, *Programma 4-ogo Sibirskogo Soveshchaniya po Prikladnoy Spektroskopii* [Program of the 4-th Siberian Conference on Applied Spectroscopy], Tomsk, 1965.
2. Panteleyev, V. V. and A. A. Yankovskiy, *Zhurnal Prikladnoy Spektroskopiya*, Vol. 3, p. 96, 1965.
3. Zhukov, A. A., et. al., *Zhurnal Prikladnoy Spektroskopiya*, Vol. 6, p. 590, 1967.

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